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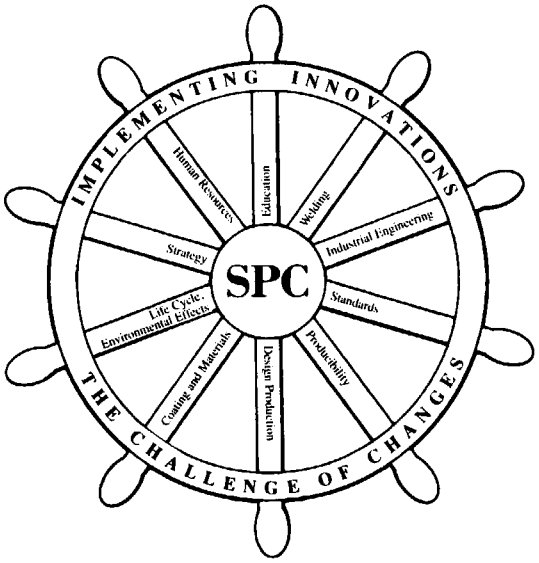

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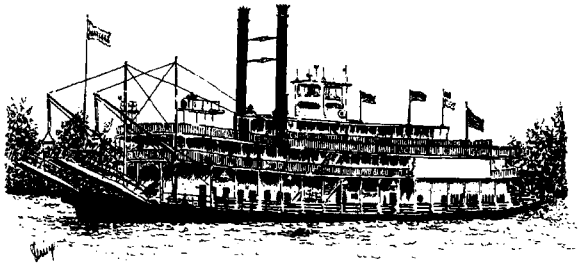

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The SP-4 Workshop on Computer Aids for Shipyards

No. 2B-3

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ABSTRACT

The shipbuilding industry in the United States stands at the crossroads of major changes in the global marketplace (1). The Society of Naval Architects and Marine Engineers Ship Production Committee Panel 4 (Design / Production Integration) is launching a major project to examine the best computer technology to assist yards to enter this new marketplace. This paper reports on the progress to date and especially the initiating national conference held in May 1992.

Participants at the conference were startled to find that the collective consensus clearly showed that no progress with better computer aids can be possible without a very significant breakthrough in the extent to which yards, suppliers, designers, and customers cooperate (2). The information captured from the participants indicates that there is a major barrier to moving critical objectives from implementation to production. Twelve objectives with 83 initiatives resulted from the conference. These depend upon short term and long term actions and continuous support from the National Shipbuilding Research Program (NSRP) over the next few years.

BACKGROUND

The idea for the SNAME Panel SP-4 initiative on computer aids came from Panel discussions regarding a series of projects to assess the status and scope of computer aids in shipyards worldwide with potential application to United States and Canadian shipyards. A five year program was discussed and the first year project (N4-91-5) was awarded to Coastal Group Technology in late 1991. CGT in turn prepared for and held an initiating national workshop conference in May 1992 with representatives of the shipbuilding, ship design. supplier, and government communities.

The workshop on computer aids was formed to create a vision of the best trends in computer aids through the next decade while at the same time providing a future business vision for the U.S. shipbuilding industry and sharing views on how U.S. shipbuilding might best provide products and services to fulfill the recommended vision.

THE PARTICIPANTS

Participants in this workshop conference were chosen for their ability to represent and articulate the needs and values of U.S. and Canadian ship construction endeavors. Of the twenty one participants the great majority were leading engineering or system executives. Several were consultants in the field and others represented major suppliers to the industry. Some correspondence from the participants modified the agenda of the workshop (3). The participants are listed in the Appendix.

THE FACILITATOR

Michael Kelly, Ph.D., and Neil Cambridge of Coastal Group Technology pioneered the procedure used to guide the participants to a focused statement of vision and policy objectives for the project. Dr. Kelly, the creator of the Advanced Management Catalyst System (AMCat) at the heart of the strategy verification method. has worked with management in companies such as Xerox Corporation, Citibank, and Asa Brown Boveri to catalyze the development and implementation of the corporate vision and new operating plans. This strategy verification procedure now has been computerized to elicit, record, process, and analyze collaborative group input. Strategy verification enables the participants to develop a road map to decision making, to integrate information in ways that are innovative and extremely powerful, and to

establish a strategic vision down to tactical steps for accomplishment and evaluation. The prerequisite impetus for this approach has been presented several times before NSRP (1,4,5).

THE STRATEGY VERIFICATION PROCESS

Successful Action

Successful action requires total knowledge, cooperation, and capacity. The strategy verification method used to facilitate the SP-4 workshop follows a process designed to continually increase the quality of action toward such perfection.

Research at Boeing Company using a similar, though less integrated system, has shown that the calendar time for projects which require team meetings can be reduced typically 91 percent. Overall meeting time can be reduced as much as 7 1 percent (6).

So many ideas are created by so many people during an advanced management catalyst workshop (AMCat) that using marker pens and flip charts is prohibitively cumbersome and time-consuming. With a skilled operator handling a system consisting of a personal computer, printer, and projector; however, three major benefits can be derived:

The facilitator is able to concentrate on eliciting the maximum participation from each member of the group

All contributions are recorded and analyzed with great precision

Statements, lists, and matrices are clearly and quickly displayed and changed, leading to more rapid audience understanding and reaction.

What happens is that the technology, combined with the advanced management workshop process, actually begins to create knowledge, unlike simple data processing which can only create information. It then makes that knowledge immediately available so that a bridge is built between the formulation of strategy and its implementation. It becomes catalytic. Figure 1 illustrates the principle which makes this possible.

This figure illustrates the inter-relationship between knowledge, society, and actions which create net positive value. As knowledge increases in validity, precision and availability, it gains leverage. Knowledge is valid when it is understood in a common context (3). It is precise when it is relevant and sufficient to describe the subject. It is available when it is at hand "just in time."

Decision Systems Can Create Value

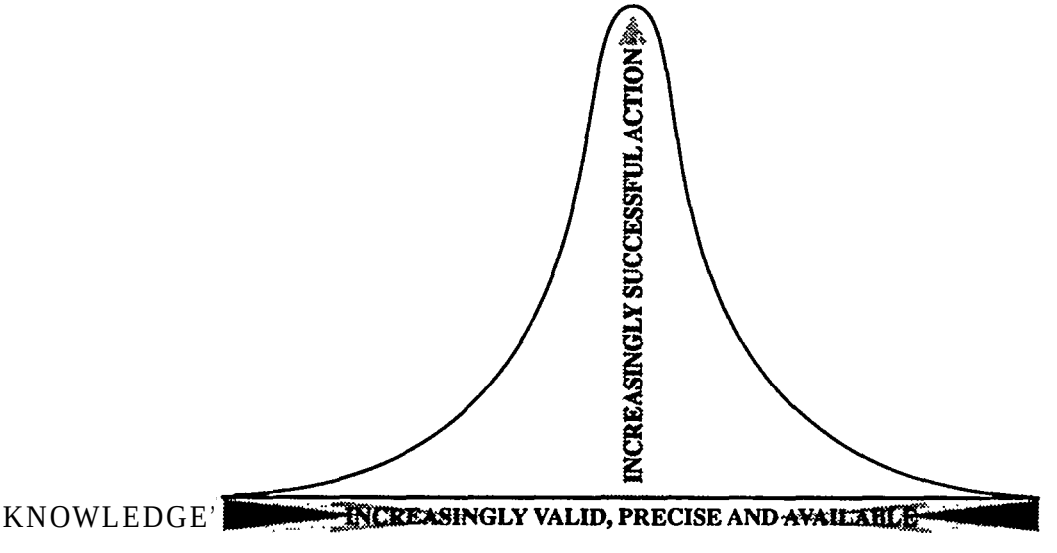

Fig. 1 Increase value to society by developing decision systems which use valid knowledge to complete appropriate action.

Knowledge, cooperation, and capacity are terms meaningful in a systems context, but they are inoperative without people. People supply knowledge and capacity. The success of action depends on the extent to which people cooperate to provide knowledge and capacity to their endeavors. Adversaries do not contribute to each other, but instead limit knowledge and the capacity of the system.

All in the shipbuilding industry are in the same boat. The total American shipbuilding system includes all knowledge and all concerned with this knowledge. Once this fact is realized by all, they become less adversarial and more willing to include new ideas from others. With valid knowledge the industry can become not only increasingly successful but also can increase its value to our whole society.

Understanding the potential of group decision systems, we were ready to work toward our first goal of assessing computer aids for shipyards. The process was carefully planned and then carried out in an intense period of time: the workshop itself.

The Event

The SP4 workshop on computer aids convened for three days, May 14-16, 1992, in Brunswick, Maine. Day one started with a demanding, non-stop brainstorming session with shared lunches and work into the evening. The second day was equally intense but focused on how to reach and realize the vision through actual actions to be taken now and in the future. On the last day each of the participants was privately interviewed for one hour to expand on the meaning of each of the action initiatives as well as on general observations.

Well ahead of the actual workshop prospective participants were sent material on the advanced management workshop facilitation process.

Dr. Kelly set the stage for the first session by asking each participant to take the role of a member of the Board of Directors of the U.S. shipbuilding industry. Each panelist was instructed to assume responsibility for setting the strategic direction for a major company whose corporate and product identity commands world wide recognition. It was left to each participant to bring his or her own set of values and perspectives into the role. The stage was further defined by stating that the group was now engaged in a three day session with management to determine the most profitable and productive future direction of the industry by providing the most appropriate computer technologies available or becoming available.

A STRATEGIC VISION FOR THE U.S. SHIPBUILDING INDUSTRY

The participants' brainstorming was launched by asking each participant to read the following statement of purpose (A) and a common, agreed upon definition of "Strategic Vision" (B):

(A) Why We've Been Brought Together

For the purpose of determining the direction of effort the shipbuilding industry will take over the course of the next decade, we invite you to assume the persona of a member of the board of directors of The shipbuilding industry. Please regard this position as an opportunity to create the future as much as it is an opportunity to respond to it.

Toward achieving this end, our first task will be to describe what the shipbuilding industry's world of customers, technology, and organizational strategy will be over the course of the next (ten) years. We will call this the shipbuilding industry's strategic vision.

At the conclusion of the two day process we are now undertaking together, we will have created a strategic vision; brain stormed every option, resource, and step we can imagine to fulfil our (The shipbuilding industry's) vision; refined those options and resources into a set of policy objectives: and mapped a general course for their implementation. We will use a procedure called the Advanced Management Catalyst (advanced management workshop) to orchestrate this process.

(B) What is Strategic Vision?

. A statement of purpose that is broad enough to involve people at every level within the industry, and inspiring enough to encourage the emotional involvement of all participants

• An announcement to internal and external

customers of what can be expected from this group

- A challenge to all ship builders based on where technology is headed

- The projection of future accomplishment that promises to extend the U.S. ship building industry's domain of influence in terms of both strategy and tactics

. The written description of this group's dream for the future.

Using this definition of strategic vision, the participants created the following strategic vision for The U.S. shipbuilding industry to be implemented over the next decade.

The Participants' Vision for the U.S. Shipbuilding Industry

We market, design, produce and support ships and other products that utilize similar processes, profitably, with greater value to our customers and in less time than anybody else in the world.

The industry has achieved a significant share of the global market and hence is recognized as a key sector of the U.S. national economy.

This industry recognizes that in order to ensure long term growth it must build better and better products at lower and lower prices and create opportunities for customers, owners, employees and suppliers.

We are:
A world leader in innovation and implementation of information, process and people management. We consistently achieve cycle times at least 10% better than the best in the international market place.

We are:
An industry which prudently reinvests in itself to support continuous improvement in process and capability.

We are:
Enterprises and business units where management and operating teams continually reconcile their processes and products within this vision.

We are:
An industry that creates an environment which supports cooperation among customers, owners, employees, suppliers, and within itself.

We are:
Proactive in applying technology to improve our products and processes.

We are:
A self sustaining. non-subsidized industrial base.

We are:
An industry which attracts, retains and motivates talented people.

We are:
An industry which delivers what it promises.

We are:
Constantly sharing knowledge with other industries to our mutual benefit.

We are:
Committed to constructing a single ship as cost effectively as multiples.

We are:
An industry that competitively services ships regardless of where they were built.

We are:
An industry which is continually re-inspired by its heritage.

Creation of a Strategic Vision for the U.S. shipbuilding industry was the most ambitious, debated, analyzed, and creative portion of the participants' activity. Under the non-interventionary guidance of the facilitators, the panel members covered every conceivable aspect of the future direction of marine production, management, and competition; debated every possible strategic scenario that might catapult the industry into a position of leadership in providing customer solutions in the future; weighed multiple approaches that might ensure capturing the majority of the participants' predictions of where customer values, technologies, economics, and marketing requirements and opportunities are leading. On almost every point, there was a minority view but rarely an unresolved conflict. Thus, the Strategic Vision was adopted and 'bought into" by the participants.

The next step in the project brought the participants from visionary definition to specific

recommendations. After creating their strategic vision for the shipbuilding industry, the participants identified well over 200 specific options including options for yard aids which could be pursued to fulfill it. After culling, 83 specific initiatives to be undertaken were recommended. These were organized into 12 policy objectives and then put in priority order.

This process forced a "bottoms up approach" on the participants in arriving at these policy objectives. Through vigorous use of brainstorming, the participants offered every conceivable action that they could think of that might be essential to implement the strategic vision and every possible support action that might be useful in implementing that vision. As evidenced in the final output, these recommended actions are sound, pragmatic, hard-hitting activities, actions, organizational adjustments, and strategic changes that, if implemented, ensure that the U.S. shipbuilding industry will "win" by fulfilling the strategic vision.

Once the participants had exhausted every possible required action for vision implementation, these actions were then grouped into objectives. The objectives were not labeled until a common thread was found whereby several recommended initiatives suggested an objective. By clustering to derive objectives rather than determining objectives and then assigning actions, the workshop's thinking was not constrained by form. Any possible action that a participant thought essential for American shipbuilders to claim and fulfill the strategic vision came out on the table and was woven into the policy objectives. The grouping of these initiatives into objectives then helped to integrate the initiatives around common mission style goals. The participants then weighed the various views of their strategic importance based on priority/urgency and feasibility in order to produce a "feasibility matrix." Then they assessed the stage of accomplishment of each objective industry-wide in order to produce a "diagnostic matrix." Both matrices are presented later.

The objectives and initiatives are first presented here as the workshop weighted them. The labels given to the objectives are purposefully brief and self explanatory. The initiatives following each objective are specific and able to be acted on - these actions are each considered necessary to fulfilling the stated objective but may not be all inclusive. See Table 1 for a brief characterization of objectives and initiatives:

Table I. Numbers of Initiatives per Objective

I	Process Definition	I5
II	Integration	8
III	Product Model Exchange	5
IV	Product/Process Model	5
V	Computer-Aided Acquisition and Logistic Support (CALS) Implementation	II
VI	Human Resources Innovation	7
VII	Follow Up	5
VIII	Industry Cooperation	9
IX	Expert Systems	5
X	Configuration Management	3
XI	Generic Modular Ship	**5**
XII	Service Life Support	**5**
	Total:	83

OBJECTIVES IN PRIORITY ORDER

I. Process Definition

Our objective is to identify the best processes, tools and measurements which support our vision. We define processes as combinations of people, equipment, raw materials, methods, and environment our industry is striving to bring together to produce our products or services.

It is pointless for us to automate existing processes which perpetuate the current inadequate state of our industry in world competition. Instead, we need to document and analyze current practices to define new processes which will lead to our vision.

For example, money should be invested first in systems that improve the competitive position of shipbuilding in the United States. Benchmarking our competitors overseas represents such a system. Then priorities need to be set based on which processes are on the critical path toward that end.

II. Integration

We can and must bring the improved processes together in a very connected way. This integrated approach will flow from design to implementation through a computer simulation of our ship as a product. The approach treats process and product as system elements and management tools. This computer simulation model must be accessible to all concerned. The complete picture of our processes must include:

- concurrent engineering

- business operations
- overall planning
- yard personnel
- all relevant databases
- proposal and detailed estimates
- work accomplished and reported.

III. Product Model Exchange

For integration to work, information must flow freely throughout our industry. Suppliers to shipyards must have access to project data promoted by good interchange standards and organizations dedicated to maintaining them.

IV Product/Process Model

Standardized definitions and information shared by the industry must be captured to document the information required to manage.

V. CALS Implementation

Such integration and clarity of definition lead to the replacement of conventional drawings with digital product models, which provide customers with on-line access to product data and encourages vendors to supply product data with their products. Thus customers, suppliers, and life cycle needs are brought together effectively and efficiently.

Note: Concurrent with this workshop, a relevant systems analysis of U.S. commercial shipbuilding practices was published (7).

VI. Human Resource

Best processes and product models cannot effect the continuous improvement needed to realize our vision. All of us in the system must be empowered by a new philosophy and understanding of computer aids, concurrent engineering, and team building.

Per his statements on public radio, research by Lester C. Thurow, Dean of M.I.T.'s Sloan School, indicates that by the end of this century people and their skills will *be the only significant source of competitive advantage in global competition.*

VII. Follow Up

We must conduct additional workshops like this one with senior management to build in follow up to this action plan. Also we must develop critical experiments and an industry wide project for reaching our goals.

VIII. Industry Cooperation

In spite of the self destructive intensity of competition between and among our organizations forced by the narrow pursuit of a single and "impoverished" customer, we must create:

- a national consortium for software
- databases of valid knowledge
- customer/producer councils
- leadership forums
- mechanisms for sharing information
- centers of excellence
- assessment and communications nets.

IX. Expert Systems

Computer systems which capture the experience of ship designers and shipyard managers can and should be developed. Parametric ship design concepts and management decision modeling tools can greatly facilitate our planning and manufacturing.

X. Configuration Management

We must apply the methods of configuration management to our industry. We must both understand and design computer systems which clearly document and maintain valid knowledge of our processes.

XI. Generic Modular Ship

We need to build a national library of reusable design modules to the parts level of detail. This may require consortiums of Navy and private shipbuilders for commercial ship production with modular designs for both military and commercial ships possibly being produced in the same facility.

XII. Service Life Support

We must develop a new ship repair strategy using advanced technology. New construction methods must be extrapolated to fulfill lifetime support applications including automated crew training aids and shipboard computer aids for at sea operations.

FEASIBILITIES

The Feasibility Matrix was one of the most revealing products of the advanced management workshop process at the workshop. Participants were asked to rate the feasibility of each objective according to the following scale:

0 Conceivable
1 Theoretically possible
2 Technically achievable
3 Innovative
4 Producible
5 Risk worthy
6 Unfamiliar process
7 Early Adopters
8 Organizationally viable
9 Widespread acceptance
10 Routine.

The feasibility rating is displayed on the horizontal axis and the priority/urgency is displayed vertically.

The matrix below (figure 2) startled the participants as it gave a shocking picture of the condition of our industry. The information captured from the participants indicates that there is a major barrier to moving critical objectives from implementation to production. The industry has little difficulty developing and demonstrating new methods and technologies; it just can not incorporate them readily! This "wall" represents a management mind set reluctant to embrace emerging team building strategies. This barrier is holding back not only applications of better computer systems to the industry but also the whole industry's effectiveness and efficiency as a whole.

Half of the objective critical to the advancement of our industry are blocked by this wall:

- Process Definition
- Product Model Exchange
- Product/Process Model
- Industry Cooperation
- Configuration Management
- Service Life Support.

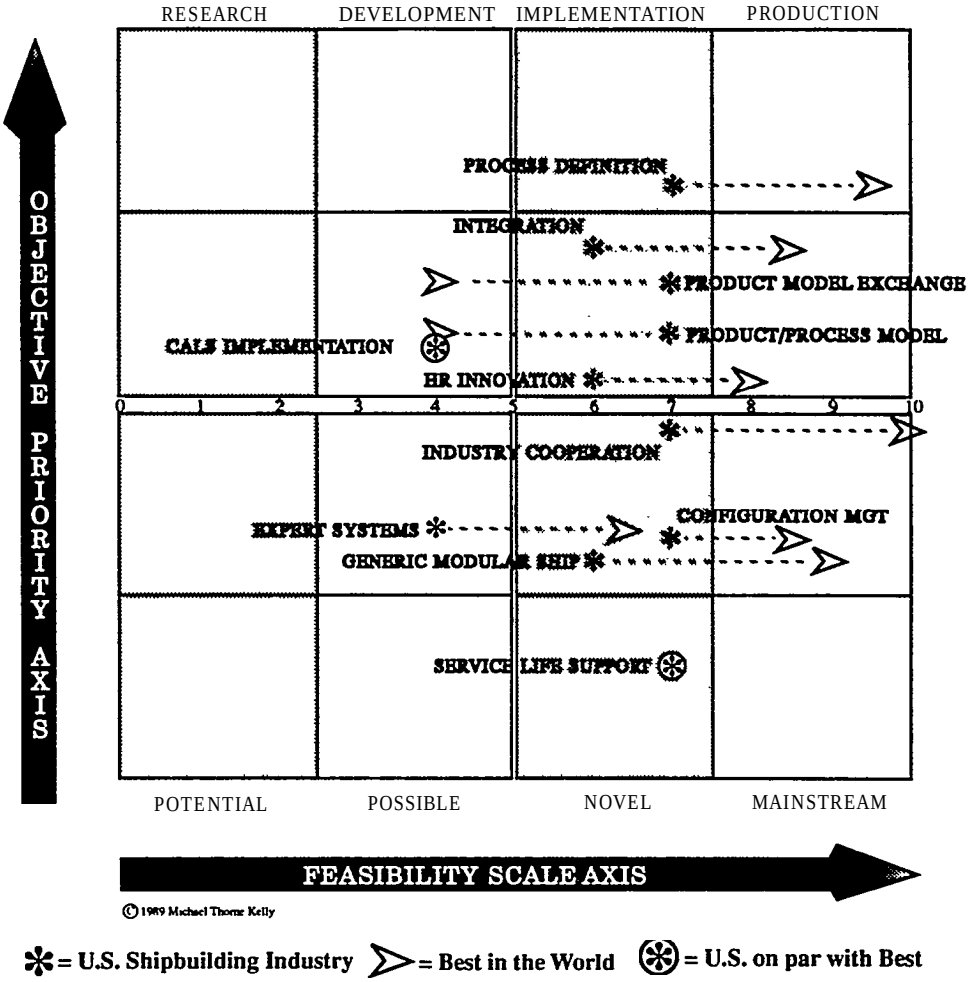

Figure 2 Feasibility Matrix

The first three of these are of the top four in priority!

All 12 objectives are portrayed on Figure 2. Behind each of the objectives are detailed initiative action items. When this conference is reported in final form, the first year of research will be published in the standard report format for NSRP. At that time each of the 83 initiatives will be detailed together with all of the pertinent interviews of participants.

DIAGNOSTIC

The workshop participants were asked to focus on the current stage of performance of the objectives within the whole industry using the performance stage scale illustrated below. The priority axis is the same as for the feasibility matrix.

The diagnostic matrix illustrates the optimum path for accomplishment. It shows the relationships between objectives as they contribute to fulfilling the vision and how well these priorities are managed.

Figure 3 below shows the priority order of action necessary to move the U.S. shipbuilding industry into viable global competition through computer technology and changes in management practices. It graphically illustrates the fit between priorities and actual use.

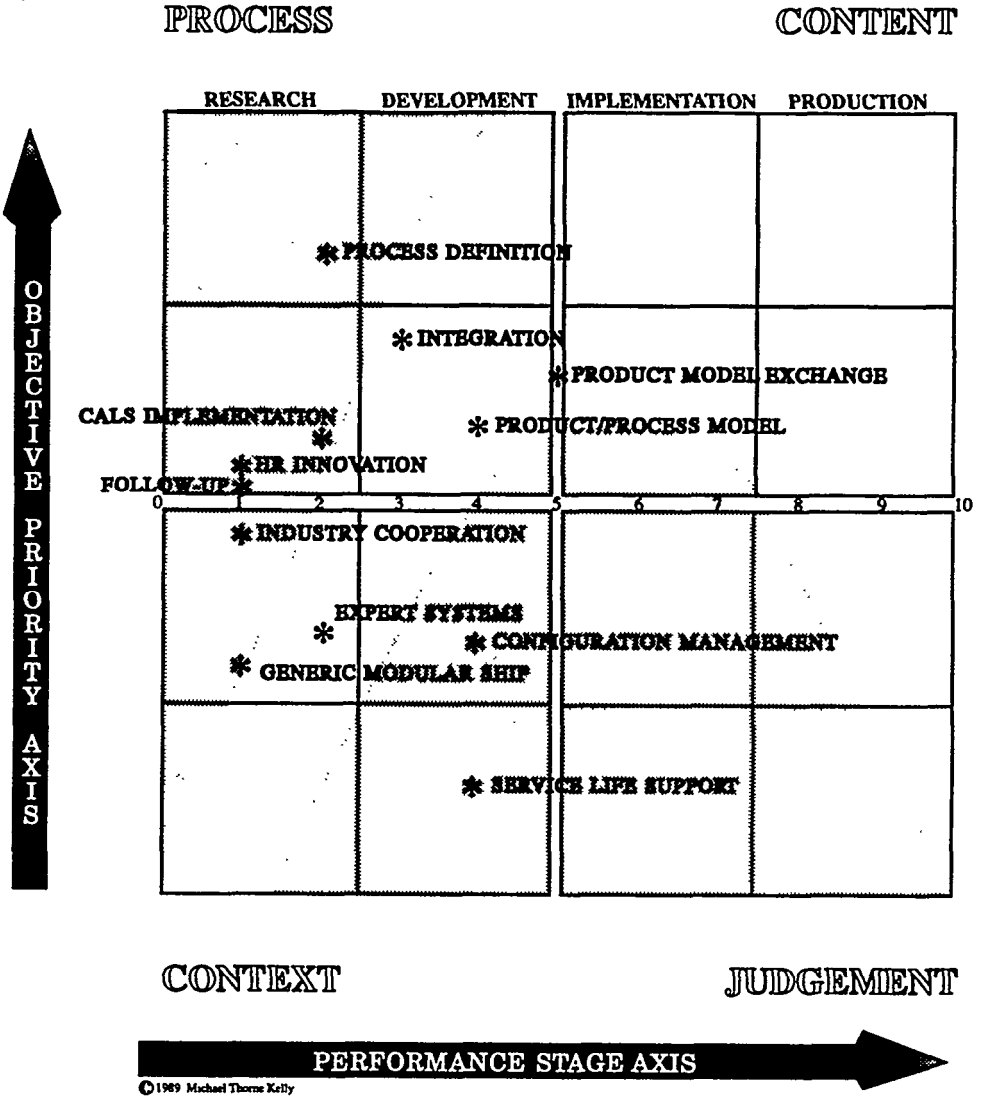

Figure 3 Diagnostic Matrix

The meaning of the performance stages is described below as presented to the participants.

Performance Stages

0 -----YOU HADNT THOUGHT OF IT UNTIL NOW.

---YOU ARE THINKING ABOUT IT: WONDERING IF IT WILL ACCOMPLISH WHAT YOU INTEND.

2 -----YOU ARE THINKING SERIOUSLY ABOUT IT; EXAMINING ITS IMPLICATIONS AND FEASIBILITY.

3 -----YOU HAVE BEGUN PLANNING. IF THIS WERE A BUILDING IT WOULD BE LIKE HAVING THE ARCHITECT BEGIN THE DESIGN.

4 ---YOU ARE OPERATIONALIZING IT. AGAIN USING THE BUILDING ANALOGY, YOU NOW HAVE YOUR PLANS, SO YOU ARE CALLING THE CONTRACTOR, THE CEMENT COMPANY, AND ETC. AND ARRANGING TO HAVE THEM CARRY OUT THEIR TASKS AS REQUIRED BY THE PLAN.

5 -YOU ARE READY TO INITIATE IMPLEMENTATION.

---THE PLAN IS BEING IMPLEMENTED BUT AS YET YOU HAVE NO FEEDBACK ABOUT WHETHER OR NOT IT IS PROGRESSING SUCCESSFULLY.

7 ----THE PLAN IS BEING IMPLEMENTED AND YOU ARE GETTING POSITIVE RESULTS BUT AS YET YOU ARE STILL INVESTING MORE THAN YOU ARE GETTING.

----IMPLEMENTATION HAS ACHIEVED INDEPENDENT MOMENTUM you HAVE PASSED THE BREAK-EVEN POINT.

9 ----YOU ARE MANAGING IMPLEMENTATION. YOU HAVE CREATED AN EFFECTIVE, EFFICIENT SYSTEM THAT REQUIRES THAT YOU Do NOTHING MORE THAN OVERSEE ITS OPERATION.

10----PRODUCTION PROCEEDS EFFORTLESSLY ALL OF THE IMPLEMENTATION IS DELEGATED LEAVING YOU READY TO UNDERTAKE YOUR NEXT PROJECT.

The lighter area on the matrix is the path of optimum accomplishment. When activity and resources are properly aligned with priorities, objectives fall on this path. According to the consensus of all participants in this advanced management workshop, the U.S. shipbuilding industry has fully 75% of its activity off the path for achieving the strategic vision.

When objectives are behind the path, like Process Definition and five others, it means that there has been insufficient assessment of the risks, rewards and demands involved relative to achieving the strategic vision. When things are ahead of the path, Service Life Support and Configuration Management in this case, resources have been prematurely allocated.

According to the facilitator, this is the graph of an industry which will be repeatedly blind sided in its attempts to fulfil the strategic vision unless crisis measures are taken to thoroughly assess the effectiveness of the objectives that are behind the path and clear the way for developing them. It will also waste resources on efforts that, though perhaps successful in themselves, will hit a glass ceiling and fail to contribute to accomplishing the vision.

His comment was that "This is a catastrophe in the making. This is the graph of a start-up industry where no one really knows what they are doing or why. The fact that the shipbuilding industry in this country is two hundred years old and encumbered with all the unforgiven sins of the past foreshadows a repeat of the U.S. steel industry's staggered pattern of collapse."

COMMENTARY FROM PARTICIPANTS

As indicated in the discussion of the feasibility matrix, all participant comments on initiatives have been recorded. A synopsis of their comments follow.

1. What is your assessment of the vision relative to where we are today?

Everyone agreed that the vision represents a worthy goal for the industry and is based on a relatively accurate overall assessment of the industry.

Repair and ship overhaul is the near term future of the industry, not new construction.

Unless there is general cooperation to support this vision as a Computer-Aided Acquisition and Logistic Support effort the industry is doomed.

It is a great vision but culturally the industry is not prepared to understand it much less implement it. Moreover there are concrete structural impediments to realizing it.

Perhaps the industry can make progress in its thinking if the industry is considered now to be simply one of many defense contracting industries tailor making ships for the Navy.

The vision is an affirmative vision, an aggressive one without question, but when you recognize that there are people in the industry capable of supporting steps toward it right now, it is not impossible at all, more a question of will than substance.

2. How can our strategic plan strengthen the Computer-Aided Acquisition and Logistic Support (CALS) initiatives?

The CALS initiatives could use a lot of strengthening. After six years we do not even have a plan.

"It appears to me that what is planned and will be planned as a result of this workshop will feed right into that [CALS]."

Some questioned the relevance of CALS to commercial shipbuilding: however most agreed that it is relevant to government regulation. It is certainly relevant to the computer tools because it makes the data exchange and makes sure the government does not ask for stuff they really do not need or will not use, as they have a tendency to do.

Implementation of CALS is a means to achieve some strategic notions that we discussed. In addition I think the strategic plan probably would be a help to implementing CALS because it tends to address the issues that CALS does not deal with. It establishes a context for CALS.

The strategic plan could function like a bridge between CALS as technology and shipbuilding as business. "There might be some commercial experience that might trim some stuff out of CALS. The proof of that pudding is interest in buying CALS."

3. What constraints need to be eliminated to strengthen the industry?

"The main thing that I think is holding us back is a lack of understanding of what the potential is that is at hand right now. The potential is to eliminate the false work, the retrieval effort, the transformation effort that occupies so much of our everyday working efforts."

We are constrained by lack of training, lack of enthusiasm among a gutted user community and by lack of management support.

There is a concern that unless progress is made on a broad front one area will advance at the expense of other areas.

The industry is locked into a drawing with pencil and paper mind set which dictates that you haven't finished the design process until you have a drawing to use as the essential basis for activity. We have to break out of that mold and accept a digital mode for product models. We need to see the drawing as something that needs to exist only in the computer.

The functional similarities across companies are much greater than our differences, but our perceptions of self interest drives us to block the progress possible through collective agreement. The government is maintaining segments of our industry but not supporting the industry as a whole to make substantial leaps forward.

It is difficult for us to relate to each other because we lack a common terminology.

The industry thinks that the Navy is the only game in town and consequently is starving in the midst of global abundance. We need an Apollo style program to build commercial ships for the world.

4. What management attitudes need to be changed?

"Everyone must realize that information technology is no longer the domain of specialists. It is having a pervasive effect on all aspects of NAVSEA's business. Because of the current fiscal environment, the rate of change is becoming revolutionary. Everyone is involved!" (8).

"The old 'theory x' management style where a manager manages by intimidation is still prevalent."

"We have too many layers of management."

"I'm pretty optimistic about the way our unit is transforming itself - I just hope we can do it in time."

"I would focus on changing the attitudes of middle management rather than senior. Many of our middle managers, especially the ones who am real good at their job, because that is what they have been doing for along time, are hung up on the notion that that is the way God intended it to be done. I see that as our shipyard's biggest

impediment. I would focus on middle management attitudes and there is no specific attitude that needs to be changed other than a willingness to change."

The industry is caught up in the attitude that all workers need a crisis to promote productivity. This palpable lie is worn out.

Management has to take the attitude of "What does it take to be profitable in the commercial business?" The question then is, "What are the appropriate computer tools for profitable commercial shipbuilding?"

5. What management methods hold the greatest promise for implementing this plan?

Total Quality Management provides an opportunity to create solutions as long as it is not presumed to be the solution itself. "The operating philosophy should be one of continuous improvement."

We need employee empowerment including trust in the knowledge of the worker to accomplish positive changes in the processes they know well.

Self directed teamwork leads to the kind of employee empowerment (at the process level) and motivation necessary to global competitiveness.

We need to identify and implement management methods which support faster cycle times, continuous improvement and more efficient use of resources.

Leadership needs to be taught at all levels of our business. Senior management does not understand the nature of leadership confusing it with authority. People on the shop floor are not training in leadership because they are expected to be followers.

6. What is the best approach to standards development for the industry?

"I have been involved with the data exchange standards and they sure have been painful. There has to be a better way."

Were the industry participants to collaborate on and finance standards the outcome would be positive.

"I think our strategic plan has to get the vision right first, we have to know where we are going. I think we have the foundation in the vision. Then we complete the analysis of best practice for a world class competitive commercial yard including identifying what tools are in that yard; informational, structural or physical tools. After that we decide which of those tools would be used across the industry. Then we standardize the tools that are in this new commercial / military shipyard. These are the tools, especially those tools that help, which are capable of migrating and communicating across shipyards."

Electronic Data Interchange is a viable approach to promoting standards in the industry.

CONCLUSIONS

So let's do it! Let us implement this action plan, because it leads us to take both short term and long term steps toward industry viability. Ultimately you cannot control what you cannot produce; therefore, production of many kinds of products is needed to not only sustain our economy but also to provide our children and grandchildren with options, Although shipbuilding represents a small part of the United States economy, it is a bell weather for complex heavy and high technology industry. Shipbuilding combines both factory line production and outdoor construction. Consequently and potentially our industry can combine the best practices of flexible computer integrated manufacturing with the best practices of complex outdoor projects.

We are not talking here about top managers alone. Middle management can be either a barrier to success or a powerful support in attitude and successful application of new approaches and technologies to this very old industry. Let us involve all levels of management in the process of keeping the ball rolling!

We can conclude that the participants in this initial study represent the problem in a most realistic manner. The message that stands out clearly from the knowledge bases assembled at the workshop: change the thinking of the shipbuilding industry and change it fast.

RECOMMENDATIONS

Let us get funded to do it! We have sounded this alarm and proposed 83 concrete steps

toward improvement, but this is only a beginning. The Executive Control Board and the SP-4 Panel must keep the momentum of this project going. Without such support the follow up to the action items will be weak or lacking altogether. With support the action plan will lead to more persons committing to more effective actions to save American shipbuilding.

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